Investigation

WINDMILL COMPETITION

Background Information

The more electricity a wind turbine can produce, the lower the unit cost of the electricity. The amount produced depends on the windiness of the site; the efficiency of the windmill, turbine, and generator; and the way the turbines are arranged.

- Wind turbines begin operating at wind speeds of around 10 mph and reach maximum output at 33 mph. At winds above 50 mph, wind turbines shut down. To be productive, therefore, wind turbines need to be located in areas that have a fairly constant wind speed between 10 and 33 mph.

- The length, shape and weight of the blades, the generator design, and the strength of the materials all affect the efficiency of a wind-power installation. To maintain an average of 15 to 50 revolutions per minute, friction must be minimized.

- Turbines in wind farms must be arranged so that they do not shadow (interfere with) each other.

An instrument that measures wind speed is called an anemometer (*an-uh-MAHM-uh-ter*). Wind speed is usually expressed in meters per second, miles per hour or knots. One knot is equal to 0.51 meters per second, or about 1,850 meters per hour.

One type of anemometer consists of three or four cup-shaped arms that rotate freely. Wind from any direction will catch one of the cups and start the anemometer rotating. The faster the wind is blowing, the faster the anemometer spins.

An anemometer and a windmill have similar designs. Both have three or four blades attached to a hub that rotates on a shaft. They differ in that the anemometer rotates on a vertical shaft and a windmill rotates on a horizontal shaft.

The objective in this activity is to design an anemometer, compare its efficiency to other students' anemometer, and then redesign the anemometer to increase its efficiency.

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WINDMILL COMPETITION INVESTIGATION CONT.

Problem *(fill in problem):* ______________________________

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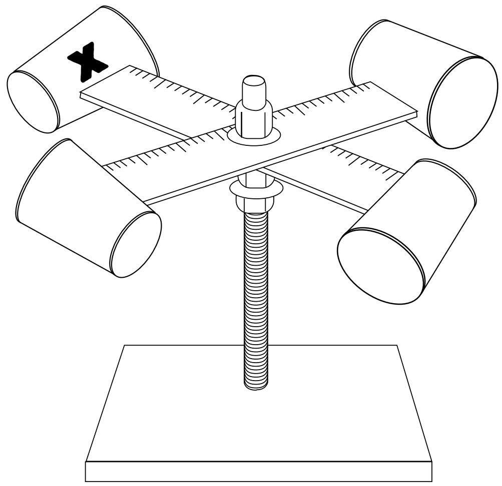
Materials

4 paper cups
2 12-in. rulers with holes in the center (inexpensive yardsticks can be cut at 12-inch intervals)
1 piece of 1/2 inch plywood 8 inches square (industrial technology classes may be willing to cut these).
1 six-inch length of screw stock
3 hex nuts
4 tacks
2 washers
1 three-speed electric fan
1 stopwatch
1 marker



Procedure

1. Use the materials above to assemble an anemometer.
2. Using the marker, put a large X on one of the cups.
3. Place the anemometer one foot from the fan.
4. Set the speed setting on the fan to low and turn it on.
5. To measure the wind speed, count the number of times the cup with the X passes in front of the fan for 30 seconds. Divide this number by 5 to obtain the wind speed and record on the data table.

   Wind speed = $\frac{\text{\# of revolutions in 30 seconds}}{5}$ = wind speed in miles per hour

6. Repeat steps four and five two more times.
7. Repeat steps four and five using the medium and high-speed settings on the fan.
8. Brainstorm how you can improve your anemometer and make those adjustments.
9. Retest your anemometer.

WINDMILL COMPETITION INVESTIGATION CONT.

Observations

Trial No.	Fan Speed	Wind Speed
1	Low	
2	Low	
3	Low	
1	Medium	
2	Medium	
3	Medium	
1	High	
2	High	
3	High	

Trial No.	Fan Speed	Wind Speed
1	Low	
2	Low	
3	Low	
1	Medium	
2	Medium	
3	Medium	
1	High	
2	High	
3	High	

If more than one fan is used in the room, note which fan you used ______________

1. What improvements did you make to your anemometer?______________________________

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Conclusion

1. Why do you think your improvements did or did not increase the revolutions per minute?

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2. Why did some groups' anemometer work more efficiently than others? ________________

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WATER WHEEL INVESTIGATION CONT.

Application

1. Take your anemometer outside and measure the current wind speed. Then check the local weather station and compare their reading with the wind speed of your anemometer. What may have caused the differences in the actual wind speed and the wind speed of your anemometer?

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2. Why was an anemometer used as a model to study windmill design instead of an actual windmill? ________________________________

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3. What would need to be done to make a windmill model instead of an anemometer?

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4. What different factors might you need to control to have a valid experiment?

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Going further

1. Try your new windmill design out and compare it to your anemometer.